CHAPTER 8

ENVIRONMENTAL IMPACTS

8-1. General. A common characteristic of breakwaters and jetties is their location in dynamic, high energy environments. Physical features of the environment where breakwaters and jetties are typically constructed reflect hydrodynamic and sedimentological conditions that have attained a dynamic equilibrium, a state of continuous change which remains balanced around some average set of conditions. Environmental impacts will occur as the system is initially imbalanced by the presence of the structure(s), and then returns to a new set of dynamic equilibrium conditions. Potential environmental impacts associated with these structures can be sorted into the following categories, all of which are interrelated to some degree: physical impacts, water quality impacts, biological impacts, and socioeconomic and cultural impacts (items 20, 21, and 97). The magnitude of severity of each type of impact can be expected to vary over short or long spans of time. Each category of impact is briefly discussed below. Because breakwaters and jetties generate essentially similar impacts, they are treated jointly.

8-2. Physical Impacts.

a. Breakwater or jetty construction is invariably accompanied by localized changes in the hydrodynamic regime. In the case of tidal inlets with either single or double jetty systems, for example, longshore currents are deflected beyond the seaward end of the structure(s) and, depending on the orientation of the structure(s) to the inlet, water circulation through the inlet is altered. The presence of a structure adjacent to a channel may cause an increase or decrease in the minimum channel cross-sectional area, which in turn is related to water current velocities and availability of sediments. Changes in hydrodynamic regime such as these provide the driving force for additional physical, water quality, and biological impacts. Breakwater configuration often produces a semiconfined water basin in which water current flows are reduced, thereby affecting the area's flushing rate. This is an important design consideration when contaminants might be present, as is often the case in small boat harbors or larger docking facilities. Breakwaters and jetties may alter water circulation patterns in a manner such that areas conducive to sediment erosion and/or deposition are created or redistributed. The rates of shoreline erosion and accretion are proportional to the magnitude of the littoral sediment transport process peculiar to a given site. Spatial extent of resultant shoreline alteration is a function of the structure's effectiveness as a barrier to littoral sediment drift as determined by the structure's orientation to the shoreline. Formation, degradation, or translocation of bars, shoals, or ebb tidal deltas are also direct results of altered hydrodynamic regimes (items 80 and 138). Another potential physical impact involves migration of channel thalwegs, particularly following construction of single jetties at tidal inlets. Predictions of changes in hydrodynamic regime can be obtained by means of physical or numerical hydrodynamic modeling investigations supplemented by experience with historical or existing field situations.

b. Physical impacts can be summarized as:

(1) Stabilized hydrodynamic regime.

(2) Stabilized bottom topography and shoreline configuration.

(3) Stabilized minimum channel cross-sectional area.

(4) Stabilized channel thalweg position.

8-3. Water Quality Impacts.

a. During the construction of a breakwater or jetty, suspended sediment concentrations may be elevated in water immediately adjacent to the operations. In many instances, however, construction will be occurring in naturally turbid estuarine or coastal waters. Plants and animals residing in these environments are generally adapted to, and very tolerant of, high suspended sediment concentrations. The current state of knowledge concerning suspended sediment effects indicates that anticipated levels generated by breakwater or jetty construction do not pose a significant environmental impact. Limited spatial extent and temporal duration of turbidity fields associated with these construction operations reinforce this statement. However, when construction is to occur in a clearwater environment, such as in the vicinity of coral reefs or seagrass beds, precautions should be taken to minimize the amounts of resuspended sediments. Organisms in these environments are generally less tolerant to increased siltation rates, reduced levels of available light, and other effects of elevated suspended sediment concentrations.

b. Indirect impacts on water quality may result from changes in the hydrodynamic regime. In addition to consideration of contaminant problems caused by reduced flushing rates, fluctuations in parameters such as salinity, temperature, dissolved oxygen, and dissolved organics may be induced by construction or by the actual presence of a structure. Potential water quality impacts should be evaluated with reference to the ecological requirements of important biological resources in the project area.

c. Potential water quality impacts can be summarized as:

(1) Temporary elevated suspended sediment concentrations.

(2) Altered levels of salinity, temperature, dissolved oxygen, etc.

8-4. Biological Impacts.

a. Biological impacts are inherently difficult to quantify. Impacts, indicated by changes in occurrences and abundances of organisms, may be masked by background "noise" due to seasonal variations in populations, ecological succession events, and natural perturbations (e.g. storms, harsh winters, etc.). The types of biological impacts discussed below range in their order of presentation from well-established to highly speculative. Impacts discussed in paragraphs b and c deserve consideration in connection with almost all breakwater and jetty construction projects, whereas those that follow merit consideration only when sufficient cause for concern has been demonstrated for a given project.

b. Measurable amounts of bottom habitat are physically eradicated in the path of breakwater or jetty construction. Given an example toe-to-toe width of 125 feet, one linear mile of typical rubble structure replaces approximately 15.2 acres of pre-existing bottom habitat. This loss of benthic (bottom) habitat and associated benthos (bottom dwelling organisms) is more than offset by the new habitat represented by the structure itself and by the reef-like community which becomes established thereon. Submerged portions of breakwaters and jetties, including intertidal segments of coastal structures, function as artificial reef habitats and are rapidly colonized by opportunistic aquatic organisms (items 139 and 144). Over the course of time, structures in marine, estuarine, and most freshwater environments develop diverse, productive biological communities. A majority of large breakwaters and jetties are rubble-mound structures, which represent excellent spawning, nursery, shelter and/or foraging habitat for numerous desirable fish and shellfish species (item 68). This development of a reef-like community can definitely be viewed as a beneficial project impact, the scale of which will vary among regional locations.

c. Water currents and turbulence along the base of the structure can produce a scouring action which prevents utilization of that habitat area by most benthic organisms. This effect is largely confined to the bottom immediately adjacent to the structure and may occur along only a portion of the perimeter, such as along the channel side of an inlet's downdrift jetty (item 81).

d. One speculative source of biological concern related to altered hydrodynamic regimes at jettied coastal inlets involves transport of egg and larval stages of fish and shellfish. Eggs and larvae of many important sport and commercial species are almost entirely dependent upon water currents for transportation from offshore spawning areas through coastal inlets to estuarine nursery areas. Jetties displace the entrance to an inlet forming a potential barrier to eggs and larvae, particularly those carried by longshore currents. Eddies or lee areas created in the vicinity of jetties may act as sinks in which nonmotile stages become trapped or are delayed. Results of hydraulic modeling studies have been inconclusive, and field studies addressing the problem are nonexistent. Several studies have documented successful movement of organisms through jettied inlets (item 38), but pre- versus post-construction data are unavailable upon which to base comparisons. Historically, in view of the fact that numerous structures have been in place for quite a long period with no apparent decline in estuarine dependent species attributable to their presence, a case can be made that such impacts, even if real, are insignificant. Similar concerns have been voiced with regard to the movements of juvenile and adult stages of various fish and shellfish. Because these are generally highly motile forms the probability of negative impact is even less significant.

e. Coastal rubble structures provide substratum for the establishment of artificial reef communities. As such, breakwaters and jetties serve as a focal point for aggregations of fish and shellfish which graze on sources of food or find shelter there. Many species are attracted to the structures in numbers, as evidenced by the popularity of breakwaters and jetties as sport fishing locations.

f. Potential biological impacts can be summarized as follows:

(1) Loss of benthic habitat and benthos in the area covered by the structure(s).

(2) Displacement of benthos due to scouring effects.

(3) Development of plant and animal communities on the substratum provided by the structure(s).

(4) Altered transport of egg and larval stages of fish and shellfish through coastal inlets.

(5) Altered movement patterns of juvenile and adult stages of fish and shellfish.

8-5. Short- and Long-Term Impacts.

a. Actual construction activities for breakwaters and jetties entail several months to several years of effort. During this period, a number of impacts of durations generally less than several days or weeks may occur. These impacts will vary in type and frequency from project to project. For example, temporary or permanent access roads may have to be built to allow transportation of heavy equipment and construction materials to the site. Grading, excavating, backfilling, and dredging operations will generate short-term episodes of noise and air pollution, and may locally disturb wildlife such as nesting or feeding shorebirds. Project planning should, to the extent practicable, schedule events to minimize disturbances to waterfowl, spawning fish and shellfish, nesting sea turtles, and other biological resources at the project site. Precautions should also be exercised to reduce the possibility of accidental spills or leakages of chemicals, fuels, or toxic substances during construction operations. Effort should be expended to minimize the production and release of high concentrations of suspended sediments, especially where and when sensitive biological resources such as corals or seagrasses could be impacted. Dredging of channels in conjunction with breakwater or jetty projects presents a need for additional consideration of short-term impacts as related to resuspended sediment effects.

b. Long-term impacts of breakwater or jetty construction are less definitive or predictable. Ultimate near field effects on littoral sediment transport can be expected to become evident within several seasonal cycles. These effects will vary according to the specific environmental setting and engineering design. For example, sediments accumulated in a deposition basin adjacent to a jetty weir can be used periodically to renourish adjacent erosional beaches. Consequences of construction on far field downdrift sediment processes are presently speculative. Also, because rubble-mound structures tend to become less permeable as they age, long-term shifts in distribution of benthic habitats at a project site may occur.

8-6. Socioeconomic and Cultural Impacts. A basic incentive for constructing breakwaters or jetties is to improve safety conditions for waterborne traffic through inlets and passes. This is the primary beneficial impact associated with construction. Other potential socioeconomic or cultural impacts are the presence of both archeological artifacts and cultural assets at a given project site. Where identified, these properties are given appropriate protection against possible loss or disturbance. Aesthetic quality of the structural design for the project also receives consideration. This is largely determined by subjective criteria, and provides a measure of how well the structure blends with its natural setting. Few options exist to minimize the visual contrast structures present against the backdrop of the coastal environment. Visual impacts, however, can be somewhat offset by improved access to the shoreline for fishing, swimming, diving, sightseeing, and other recreational activities. Attraction of many game fish to breakwaters and jetties underscores the value of these structures as desirable fishing spots, particularly for the nonboating public. High public utilization patterns of breakwaters and jetties also serve to support bait and tackle shops and to further stimulate local economies.

8-7. Evaluation of Project Alternatives. Each breakwater or jetty project scenario should incorporate engineering design, economic cost-benefit, and environmental impact evaluations from the inception of planning stages. All three elements are interrelated to such a degree that efficient project planning demands their integration. Environmental considerations should not be an afterthought. Structure design criteria should seek to minimize negative environmental impacts and optimize yield of suitable habitat for biological resources. This can be achieved by critical comparisons of a range of project alternatives, including the alternative of no construction at all. Various engineering design features can be incorporated into an optimal ecological alternative. For example, selection of a design specification for a less steep alternative of side-slope angle will maximize the availability of intertidal and subtidal habitat surface area. The size class of stone used in armor layers of rubble structures is another engineering design feature that has habitat value consequences. The large armor material results in a heterogeneous array of interstital spaces on the finished structure.